

Mining Megasites: Lessons Learned

The final charge to the committee was to assess “lessons from the Coeur d’Alene case that may be applicable to other similar Superfund sites.” The committee believes that there are some lessons to be learned. Certainly, it has observed a number of problems in the expansion of the Superfund process to operable unit 3 (OU-3) in the Coeur d’Alene River basin. Some of these problems resulted from the way the expansion was undertaken, and others appear to be inherent in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process. However, the committee does not question the overall goals of protection and restoration of human and ecologic health that are embodied in the CERCLA legislation. In touring the Coeur d’Alene River basin and reviewing studies extensively detailing the ubiquity of contamination, it was obvious that there were human and ecologic health risks in the basin that require remediation. The potential adverse economic implications, such as reduced real estate values, created opposition to a Superfund site designation both locally and within the Idaho State Government, although such tension is not unique to the Coeur d’Alene site. This chapter addresses issues and opportunities associated with large complex mega-mining sites under Superfund. The discussion is informed both by perspectives gained through experience with the Coeur d’Alene River basin site, as well as committee members’ broader insights and observations. It is not a comprehensive review, but a digest of the issues and an outline of conclusions and approaches for facilitating the effective management of these large and complex sites.

APPLICABILITY OF THE SUPERFUND PROCESSES TO MEGASITES

The Coeur d'Alene River basin is one of the largest mining-related Superfund sites in the United States. It is not, however, unique. For example, just east of the Idaho-Montana border, the Clark Fork Operable Unit of the Milltown Reservoir-Clark Fork River Superfund site includes 120 river miles of the Clark Fork River contaminated with metals stemming from mining activities in upstream reaches (EPA 2004a). A 2004 report by the U.S. Environmental Protection Agency (EPA) Office of Inspector General (EPA 2004b) identified 63 hard rock mining sites (which do not include coal mining) listed on the National Priorities List (NPL), another 82 that were on Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) but had not yet been listed on the NPL, and 11 potential CERCLIS/NPL sites.¹ These represent only a small portion of all the abandoned hard rock mining sites in the United States. A Western Governors' Association survey estimated that there were at least 400,000 abandoned or inactive hard rock mining sites in the West (WGA 1998a,b) and the Mineral Policy Center estimated in 1995 that, nationwide, there were 557,000 abandoned mines (Custer 2003). Although many of these are small sites presenting little or no human health risks, the EPA Inspector General found that the total cost of cleaning up the sites on the EPA inventory could be as much as \$24 billion and that at least 19 of the sites already listed on the NPL are likely to have cleanup costs of \$50 million or more (EPA 2004b).

By one formulation, these would be considered "megsites."² A Resources for the Future study has assessed the impact of such megasites on the budgetary state of Superfund (Probst et al. 2001), and a recent EPA advisory committee report (NACEPT 2004) discussed the issue of megasites and possible management options but provided no recommendations.

Mining megasites such as Coeur d'Alene typically involve multiple contaminants and contaminant sources and large volumes of waste material that have accumulated over many years of mining activity and are dispersed over wide areas. Large quantities of mining-related contaminants may have been deposited many miles from the original sources. Soils, sediments, surface water, and groundwater may be contaminated, and the hydrological relationships between these media may be complex and difficult to characterize.

The Superfund process has some serious difficulties in addressing this type of site. The following discussion focuses specifically on large mining

¹CERCLIS contains a list of all hazardous waste sites that are on the NPL or are being considered for the NPL. Many sites included in CERCLIS are unlikely ever to be listed on the NPL.

²An EPA advisory committee characterized a Superfund site as a "megsite" if any combination of remedial action costs excluding long-term remedial actions exceeds \$50 million (NACEPT 2004).

sites like the Coeur d'Alene River basin. Although other Superfund sites may show similar characteristics and, therefore, experience some of these problems as well, the extrapolation to all megasites as conventionally defined in monetary terms is limited, as many of the issues stemming from large mining areas relate to the large areal extent and complex nature of the site, and not simply projected costs.

PROBLEMS OBSERVED IN APPLYING SUPERFUND TO MEGA-MINING SITES

As it reviewed the work that was done in attempting to identify remedies for OU-3 and problems at other mining areas being cleaned up under CERCLA, the committee observed a number of problems in applying CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) to mining megasites. As indicated later in this chapter, EPA attempted to overcome some of these problems within Superfund regulations, but some appear to be inherent in the program. In recognizing these problems, the committee is not suggesting that CERCLA be amended to allow it to deal with them. The law was intended to address specific problems associated with environmental contamination that poses risks to human health and the environment and should remain focused on eliminating that contamination. Other federal, state, and local programs that can address the limitations observed in Superfund often already exist.

No Final Remedy

The focus of the NCP governing implementation of CERCLA is on identifying and implementing a final remedy (40CFR 300.430 (f)(4)), but the concept of a final remedy may not be appropriate for some megasites because this term implies that there is a final solution that can be clearly defined in advance of remediation (Moore and Luoma 1990). In the case of large mining sites, where remediation may involve many decades of sequential remedial actions, and institutional controls may be required in perpetuity, there may never be a final remedy. Indeed, EPA believes that more than half of the mining sites currently listed on the NPL will require operation and maintenance in perpetuity (EPA 2004b).

The most obvious problem with "cleaning up" megasites such as the Coeur d'Alene River basin is the massive quantities of contaminated waste materials (including waste rock, tailings, and tailings-contaminated sediments) that cover a large geographic area in a variety of upland, wetland, and aquatic environments. This complexity and volume of contaminated material practically eliminate the potential to completely remove, cap, and treat the contaminated materials, and make practical and effective remedies

very difficult to design and implement. Indeed, the volume of mining wastes present in the Coeur d'Alene River basin is so large that it is doubtful that complete removal can ever be attained. As indicated in Chapter 3, there are more than 100 million cubic yards of contaminated materials in the basin, much of which underlies buildings, roads, and railroads. Even if there were sufficient money and consensus to remove all these materials, it would be very difficult to find a place to put them where they would not create a threat of recontamination.

Even the limited removals proposed for OU-3 will be costly, difficult, and disruptive. In some cases (particularly the removals proposed to protect fish and wildlife), they may not even be feasible. The extent to which proposed remedial measures would reduce dissolved metals concentrations in the river is unclear. And the proposed removals can generate significant external costs in the form of large numbers of truck trips and associated road maintenance, noise, traffic, and accidents and will affect local populations and infrastructure over many decades. Other solutions (for example, chemical fixation and capping) may be feasible at some locations but could not be applied throughout the basin. In short, there are no obvious engineering solutions to a contaminated region as large and geographically complex as the Coeur d'Alene River basin. Remediation must be viewed as a long-term process involving numerous individual remediation projects, only some of which can be specified at the beginning.³ Given the inevitably high uncertainty about the design and ultimate success of the proposed remedies, any estimates of the duration and cost of the remediation are necessarily crude approximations.

A Long-Term Process

Because of the difficulty of implementing a final remedy, the cleanup of a site like Coeur d'Alene will require a long-term commitment to implement and maintain the cleanup actions that are undertaken. Although the committee has concluded that the remedies proposed for the protection of human health will likely be effective in achieving their goals, they will require continued efforts to control land use, protect the integrity of the remedies, and deal with flood-related recontamination, which is inevitable in a watershed like the Coeur d'Alene River basin.

The need for long-term commitment is even greater in the case of the remedies to protect the environment. Here, EPA admits that the expenditure of hundreds of millions of dollars over three decades will be only a first

³Recognizing this problem, the EPA National Remedy Review Board recommended that the environmental protection remedies proposed for OU-3 be designated "interim" remedies (NRRB 2001).

step in achieving its environmental protection goal and, if nothing more is done, it will still take hundreds of years to achieve the water-quality standards established to protect aquatic resources.

For all the above reasons, cleanup of mining megasites necessarily must be viewed as a long-term process with an uncertain outcome. Management of these sites over the many decades needed to complete the remediation process requires the development of institutions with the capability to oversee engineering operations, minimize the impact of remediation on local communities, and maintain the institutional controls needed to maintain human exposures at acceptable levels. It also requires the implementation of a long-term monitoring strategy that will (1) provide more specific information on the causes of the human health and environmental risks and the sources of contamination causing these risks, (2) evaluate the effectiveness of remediation efforts, and (3) monitor the overall changes in human and environmental health being experienced.

Limited Scope

The Superfund process was established to address a particular, limited problem—risks to human health and the environment posed by contaminated wastes. But, particularly in megasites like the Coeur d'Alene River basin, the contamination is likely to be only one of the problems creating these risks. Lack of access to adequate health care, unemployment, poverty, and a number of other factors can have as much of an impact on community health as the contamination from mining wastes.

On the environmental side, even if the concentrations of all metals in water and soil could be reduced to nontoxic levels, the degree of habitat modification that has occurred within the basin is probably sufficient to prevent fish and wildlife resources from returning to the conditions that existed before mining. The success of these efforts could be substantially influenced by factors such as how the forests in the basin are managed.

It probably would be much more effective and efficient to address the human health and environmental problems in these areas with a program that could address all these different factors in an integrated fashion. However, most of these contributor problems lie outside the purview of Superfund, and, therefore, its funds cannot be used to address them, even if by so doing the agency could reduce the total cleanup costs.

These other factors are also likely to limit the effectiveness of the cleanup efforts in achieving the goals of protecting human health and the environment. For instance, aquatic communities are limited by impaired habitats as well as chemical exposures. Reducing chemical concentrations to safe levels will not lead to ecologic recovery if physical aspects of the habitat remain impaired. Healthy aquatic ecosystems can exist in the pres-

ence of modestly elevated levels of contaminants, but, even in the absence of chemical stressors, healthy aquatic systems will not exist in degraded habitats.

The Liability Problem

The Superfund legislation incorporates what many consider to be the most stringent liability provisions in federal law—retroactive, perpetual, joint and several,⁴ and absolute. As appropriate as these standards may be for holding “responsible parties” liable for paying for the cleanup of these sites, they are said to discourage contractors from becoming involved in the cleanup activities and particularly discourage the use of innovative and other nontraditional cleanup approaches. This may be an issue at hard rock mining sites where the wastes contain valuable minerals.

One possible approach to such sites is to re-mine the wastes with modern technologies that remove these minerals (NRC 1999, p. 72).⁵ Such an approach would have several advantages: (1) contaminants would be removed from the basin environment and the potential for recontamination eliminated (Moore and Luoma 1990); (2) the net cleanup costs would be reduced by the value of the recovered minerals; and (3) such an approach would be one of the few options that would satisfy the preference in CERCLA for remedies that reduce the toxicity of the wastes. As indicated in Chapter 2, tailings have been re-mined and reprocessed in the past in parts of the Coeur d’Alene River basin.

The strict liability provisions of CERCLA, however, discourage the re-mining approach. This option likely could be undertaken only by an established mining company with adequate technical expertise and financial resources. But such a company, if it were to become involved, could be putting itself at risk of being designated a PRP (potentially responsible party) responsible for the entire cleanup cost. Any established mining company with the resources necessary to undertake such an effort likely would be reluctant to put itself at such risk, particularly when the financial rewards probably would be limited.

The 1986 SARA (Superfund Amendments and Reauthorization Act) amendments to CERCLA established a special liability category for firms involved in cleaning up Superfund sites (42 USC § 9607(b)). Their liability changed from an absolute liability to one based on a standard of negligence. However, the joint and several provisions still apply so that a company

⁴Joint and several liability means that all responsible parties are jointly responsible for the entire cleanup cost, and each of them individually can be held responsible for paying these costs.

⁵The committee did not assess whether such re-mining might be a viable option in addressing the contamination in the Coeur d’Alene River basin.

involved in cleanup theoretically could be held responsible for cleaning up the entire site.

In some cases, government agencies have indemnified organizations involved in cleanup operations. EPA did so before passage of the 1986 amendments, and other government entities have done so in special circumstances—for instance, when they are the owners of the contaminated site (and, therefore, are liable in any case). The effect of these liability provisions on remediating mining sites is described in recent reports by Trout Unlimited, a conservation group that has partnered with the U.S. government in an effort to remediate abandoned mine sites (Trout Unlimited 2004a,b).⁶

Funding Limitations

The need for long-term management of these sites and the desirability of addressing issues beyond contamination resulting from the disposal of wastes highlights the limitations on funding available under Superfund. Initially, CERCLA established a special dedicated tax on oil and chemical companies to fund cleanup activities where there was no financially viable responsible party. This taxing authority, however, has expired, and Congress now funds the program from general revenues through annual appropriations.⁷ Particularly under current budget conditions, the availability of adequate funding in the future is uncertain. The lack of a secured funding stream raises serious concerns about how a remediation program expected to last for decades if not centuries can be successfully implemented.⁸ Funding interruptions would not only disrupt the remediation efforts but could even make the situation worse (for instance, if a wetlands restoration project were disrupted after the excavation stage but before the appropriate vegetation could be reestablished).

A second limitation associated with Superfund funding is that use of the funds is restricted to furthering the purpose of the legislation; they cannot be used, for instance, for general community improvement, wildlife management, or economic development projects.⁹ These restrictions inhibit adoption of the comprehensive management approach discussed above.

⁶“Existing laws may actually create a disincentive for private entities such as TU to cleanup abandoned mines, and funding is woefully scarce for restoration efforts.” Chris Wood, Trout Unlimited Vice President for Conservation Programs.

⁷Even if the special Superfund tax were still in effect, the companies paying this tax could reasonably object to substantial amounts of these funds being used to clean up hard rock mining sites for which they had no responsibility.

⁸Funding options for long-term stewardship approaches have been discussed in a recent NRC report (NRC 2003) and Resources for the Future has analyzed different approaches for addressing this problem through establishing trust funds (Bauer and Probst 2000).

⁹Funds recovered from a Natural Resources Damage Assessment can be used for wildlife improvement projects.

A third funding issue relates to payment of costs associated with cleanup versus operation and maintenance (O&M) costs. At sites like the Coeur d'Alene River basin, when the government is paying for most of the cleanup work because there is no financially viable responsible party, the federal government pays for 90% of the construction costs, with the state paying the other 10%. However, the state is solely responsible for paying all the O&M costs starting a year after construction is declared to be complete.¹⁰ Thus, even if a long-term management option was determined to be substantially less expensive than a construction option achieving the same result, the state would have a strong financial incentive to favor the construction alternative if the long-term management option was deemed to fall in the category of O&M. Such incentives have the potential to bias the remedy-selection process because the state must concur with the selected remedy.

NCP Threshold Criteria

Although not unique to megasites, some of the criteria for remedy selection under Superfund make the process more difficult, at least as they are usually interpreted. The threshold criteria, according to the NCP, are to "protect public health and the environment" and "satisfy ARARs [applicable or relevant and appropriate requirements]." Any proposed remedy must meet these threshold criteria. In the case of the Coeur d'Alene River basin, EPA's modeling studies indicate that hundreds of years will be required to meet these goals, regardless of how much remediation is performed. Unless one envisions a remediation program lasting for several centuries, one must question whether these types of ARARs are appropriate criteria for remedy selection. Villa (2003) refers to this as "Perhaps the most intractable problem for ecologic protection":

Now, here's the rub: if CERCLA requires remedies to attain ARARs, and ARARs for the Coeur d'Alene River Basin remedy include water-quality criteria, yet such criteria could not be met for less than 200 years at best, how can CERCLA be satisfied? The answer lies in the inherent flexibility of the Superfund statute and its implementing regulations. The statute itself authorizes ARARs "waivers" in specified circumstances. However, these waivers only apply to satisfaction of ARARs. There is no statutory

¹⁰For some types of cleanup, particularly those related to groundwater and surface-water cleanup, the operation of treatment systems or other measures for a period of up to 10 years is considered part of the remedial action, and the state's obligation to fund O&M begins after this period has ended (GAO 2003; 42 USC § 9604(c)(6) [2003]; 40 CFR § 300.435(f)(3) [2005]).

waiver for the other threshold criterion of protecting human health and the environment. In the Coeur d'Alene River Basin, not only are water-quality criteria exceeded, but the aquatic life intended for protection by such criteria are also at risk. Therefore, waiving the ARARs in this case would offer no relief from the independent statutory obligation to protect the environment.

Particularly at sites as extensive and complex as the Coeur d'Alene River basin, it appears more reasonable to define protection of the environment in terms of restoration of normal ecologic functions rather than reduction in chemical concentrations below theoretically protective thresholds. These statements should not be construed to indicate that a decreased level of environmental protection is acceptable. Rather, measured end points and goals should be based on achieving characteristics of healthy aquatic ecosystems (for example, macroinvertebrate diversity, numbers, and composition; habitat indices; and fishery markers) and not on achieving a specified concentration of contaminant.

This approach is, in fact, consistent with recent trends in water-quality management throughout the United States. With active encouragement and technical support from the EPA Office of Water, many states are using "biocriteria" (indices of aquatic community composition) to supplement or replace numerical concentration standards as a means for determining whether water bodies can support their designated uses (Barbour et al. 1999). At the Lower North Potato Creek site in Polk County, Tennessee (discussed further below), Tennessee's biocriteria are being used to define the performance goals for site remediation.

A Bureaucratic Process

To many observers, cleaning up a site under Superfund appears to be a very bureaucratic, cumbersome, and inefficient process. Millions of dollars and many years can be spent undertaking studies, producing massive reports, and attempting to come to agreement on a "remedy" that will adequately protect human health and the environment while complying with the other requirements of CERCLA. This is done according to the extensive procedures established under the NCP. However, this process was established initially to address more limited industrial waste sites, and it is not clear that the process is appropriate for cleanup at a large geographically complex mining megasite like the Coeur d'Alene River basin.

Complexities inherent in an ecosystem as multifaceted as the Coeur d'Alene River basin do not mesh well with the rigidity of the Superfund process. The Superfund process calls for EPA first to gather all the necessary information (the remedial investigation [RI] phase), then evaluate al-

ternatives for addressing all the human health and environmental risks identified in the information-gathering stage (the feasibility study [FS] stage), and then decide on the best remedies for reducing these risks to acceptable levels (the record of decision [ROD]). Conceptually, each stage is completed before the next one begins (although, in practice, the RI and FS are often combined).

At most sites, the OU being assessed addresses only one or two closely related problems, and this process works reasonably well. In the Coeur d'Alene OU-3, however, there are a large number of different problems. Some, like the contamination of yards, are fairly easy to assess. Others, like the reduction of dissolved metals in the main stem of the river are much more difficult. By combining these different problems into one OU and subjecting them to the process established in the NCP, EPA must attempt to answer all the questions for all the problems before it can attempt to remedy any of them.

As a result, the agency must delay action on addressing the more tractable problems until it has all the information it needs to decide what to do about those that are less easily addressed, or, alternatively, it must propose remedies for some of the problems with inadequate information.¹¹ In OU-3, the first option would have resulted in substantial delays—perhaps decades—in efforts to reduce human health risks while the agency collected information and conducted experiments on possible ways of solving the basin's very complicated environmental problems. The agency adopted the second option, which allows it to begin work on reducing the human health risks but leaves substantial confusion about how it will address many of the environmental problems. It has proposed remedial actions for addressing these environmental risks, but this may have been largely a paper exercise because there is so much uncertainty about the effectiveness of the proposed remedial actions, or even whether they can be implemented. Although these considerations also exist for smaller, less complex Superfund sites, the complexity of these large geographically diverse sites like the Coeur d'Alene River basin dramatically increases the difficulty in developing workable remedies for every problem before beginning action on any of them.

This dilemma was very apparent during the committee's information-gathering and deliberation process. Questions to EPA about specific operations or technologies noted in the selected remedy were often answered with uncertainty, as the actual process was not yet known or formally selected, and decisions were deferred to the remedial design stage. As stated

¹¹EPA can conduct emergency removal actions under the NCP without preparing the series of reports required to decide on an appropriate remedy.

by EPA, “While the ROD establishes the general concept, intent, and goals of the remedy, RD [remedial design] and RA [remedial action] are where design and construction details are developed and implemented” (EPA 2004c). Thus, much of the effort that has gone into evaluating and costing alternatives may not be used for the final solution.¹²

The development of decision documents that subsequently went unused was particularly apparent in the review of environmental protection remedies. For example, little use is made of the extensive detailed analyses and development of preliminary remedial goals presented in the ecologic risk assessment in developing the selected remedy. The FS presents voluminous documentation and goes to great lengths to select, document, cost, and compare five alternative strategies. However, none of these remedies was selected. The ROD selects a remedial strategy that may or may not be conducted owing to on-the-ground considerations. This is not a fault of EPA but rather an artifact of the Superfund process that requires development of decision documents in this fashion, in an environment not conducive to encompassing descriptions and predictions.

As an area increases in complexity, the certainty of cost, volume, and remedial efficacy estimates decreases as does the certainty that selected decisions will be conducted. In reality, these large geographically complex sites like the Coeur d’Alene River basin cannot be remediated in a short time frame, and efforts to describe the entirety of the problem and chart a path to completion (as attempted in the Superfund process) become less realistic with increasing complexity of the site. These decision documents—even when based on best understanding and engineering practices and considering the uncertainty involved—open the agency to criticism that the decisions are not being followed and/or are incorrect. Under the current system, this may be unavoidable.

¹²One example is the extensive effort made to describe, cost, and compare remedial activities within Canyon Creek. Five alternatives were considered. Approaches outlined in these alternatives included excavation and removal of floodplain deposits and waste rock, adit water treatment, pipeline construction, active and passive treatment systems, groundwater treatment, bioengineering controls, in-stream deflectors, and repositories. However, none of these alternatives was selected because they all “would be very difficult, costly, and time consuming” and the agency wanted to “focus on identifying cost-effective technologies for improving downstream water-quality” (EPA 2002, p. 12-25). The selected remedy described in the ROD states that “one potentially cost-effective approach that will be evaluated is to intercept the creek water in lower Canyon Creek and remove metals using passive treatment.” For this “potential approach,” the ROD includes a detailed cost estimate (\$15 million), provides an engineering drawing, and estimates a reduction of 322 pounds of zinc per day. The committee later learned from EPA during a tour of the basin that there were no longer plans for the passive treatment system described in the ROD.

OPPORTUNITIES UNDER SUPERFUND

Can these problems be fixed within the existing Superfund framework? Villa (2003) argues that the Superfund program is the only program comprehensive enough to deal with sites as complex as the Coeur d'Alene River basin and that the program is flexible enough to satisfy all contingencies. He points out that EPA attempted to use its other authorities to address the contamination problems outside of the "box" and these authorities were inadequate.

EPA does, in fact, take advantage of much of the flexibility that the Superfund program can provide. For instance, many Department of Energy (DOE) and Department of Defense sites are very large and complex, often experiencing extensive contamination in a variety of ways and from a variety of sources. Cleanup of these sites is performed under Federal Facilities Agreements between the agency responsible for the site, EPA, and responsible state regulatory agencies. Whicker et al. (2004) describe the remediation approach adopted for DOE's weapons complex that involves a combination of institutional controls, land-use planning, and active remediation. Substantial acreages at several of these sites have been set aside as natural areas. Because these areas have been protected from human intrusion for more than 50 years, they provide habitat quality that generally is substantially higher than is present in the surrounding landscapes. DOE, EPA, and state agencies have agreed that in many of these cases the adverse effects associated with remediation would be greater than the harm caused by current chemical and radiological exposures. Cleanup standards for these areas may be relaxed compared with standards for areas slated for industrial or residential development, because human exposures are expected to be limited by institutional controls. These sites, of course, have the advantage over the Coeur d'Alene River basin that the government owns the entire site and, therefore, has full control over how the site will be managed and what access will be provided to the site in the future.

The East Tennessee Copper Basin is a nongovernment site where EPA has demonstrated substantial flexibility under Superfund (EPA 2004d). This former mining and ore-processing district in Polk County, Tennessee (the Copper Basin), is one of the largest contaminated sites in the eastern United States. Soil, sediment, and water throughout the basin have been severely degraded by metals contamination and acid rock drainage. Severe soil erosion has occurred, resulting in deposition of several feet or more of sediment in the two creeks that drain the basin. Remediation of one of these areas, the North Potato Creek Watershed, is being managed by the responsible party (Glenn Springs Holdings) under the Superfund Alternatives Program. In this program, EPA has secured settlement agreements for PRP-led cleanups without listing the site on the NPL. Settlements and cleanups at

Superfund alternative sites are intended to be equivalent to settlements and cleanups at sites listed on the NPL and should provide for timely action that meets the same cleanup standards as if the site were officially designated (EPA 2004e).

At the East Tennessee Copper Basin site, requirements for remediation of the North Potato Creek watershed are defined in a consent order between Glenn Springs Holdings (GSH) and the Tennessee Department of Environmental Conservation (TDEC). The consent order requires GSH to restore the “biological integrity” of North Potato Creek, as defined in state water-quality regulations. However, the order does not prescribe a specific remedy, and there is no explicit timetable for completion. GSH must continue the remediation until the biological performance goal is met. Because TDEC defines biological integrity in terms of the characteristics of benthic invertebrate communities present in unimpaired streams, waste removal, acid drainage control, revegetation, and in-stream habitat restoration will all be required to meet the site performance goal. TDEC and GSH have implemented a site-wide biological monitoring program intended to measure progress toward the goal and to identify the specific chemical and physical stressors contributing to the impairment of different on-site stream reaches. GSH intends to apply an adaptive management approach to the site, in which metrics for both engineering performance and biological performance are used to measure the success of each remediation project and determine the need for further actions.

From an institutional perspective, the Copper Basin site had the advantage that there were viable private responsible parties capable of and agreeable to performing the cleanup work under a consent decree. Availability of a willing PRP permitted the site to be managed under the Superfund Alternatives Program and facilitated the implementation of an unusually flexible and innovative approach to remediation.

The Clear Creek Watershed in Colorado provides another example of conducting a cleanup under an “informal” basin-wide approach (Pring 2001; EPA 2004f). EPA listed the entire upper watershed of this basin on the NPL in 1983 but has attempted to promote the cleanup of much of the basin through a Clean Creek Watershed Forum that includes more than 50 governmental and nongovernmental organizations. Some of the work is being conducted under Superfund, some by private companies, and some by state or local governments and environmental organizations. Part of this cleanup involves re-mining of mining wastes.

EPA has also demonstrated substantial flexibility in cleaning up the Coeur d’Alene River basin. For instance, as frustrating as it may be for basin citizens and others attempting to review the agency’s plans, the agency’s approach to deferring the final decision about how proposed remedial actions will be implemented is practical and reasonable at

sites involving such inherent complexities and uncertainties as Coeur d'Alene.

The agency has demonstrated its flexibility in the Coeur d'Alene River basin in a number of other ways as well. Its agreement to establish a Basin Environmental Improvement Project Commission (BEIPC) made up of representatives from Idaho, Washington, the Coeur d'Alene tribe, and county officials as well as the EPA Region 10 Administrator is an innovative management approach.¹³ The BEIPC is responsible for setting priorities, directing and coordinating an annual work plan, and generally overseeing environmental remediation and natural resource restoration projects in the Coeur d'Alene River basin (BEIPC 2004). To support its efforts, it has established a technical leadership group (TLG), composed of 23 government entities, and a citizens' coordinating council. This is apparently the first time that EPA has assigned such responsibilities to such an organization (EPA 2004g).

Another example of EPA flexibility is the agency's inclusion of other agencies such as the U.S. Geological Survey, the Fish and Wildlife Service, the Forest Service, and the Bureau of Land Management in helping characterize the contamination problems and implementing the cleanup program. The efforts of all these agencies are coordinated under the auspices of the BEIPC, and they are all represented on the TLG responsible for evaluating proposed technical studies and remedial activities. Few Superfund sites have as broad participation from federal agencies as the Coeur d'Alene River basin.

The Basin Environmental Monitoring Plan the agency has developed is much more extensive and comprehensive than normal for a Superfund site. This plan appears to recognize the complexities and uncertainties of the system and should provide much of the information needed to make informed decisions about the most important and effective cleanup approaches.

Finally, EPA deferred action on cleaning up Lake Coeur d'Alene to allow the state, tribal, and local authorities to develop and implement a lake management plan addressing the human and environmental health risks that the lake may present.

Thus, in many ways, the current cleanup strategy appears to recognize the complexities of the system while working within the constraints of CERCLA and the NCP. At this and other sites, the agency has demonstrated an ability and willingness to take advantage of the flexibility that Superfund provides, particularly if there are viable parties willing and able to accept responsibility for the cleanup activities.

The flexibility that Superfund presents, however, does not appear sufficient to address all the issues identified by the committee. The fund cannot

¹³The committee was not charged with considering the structure, development, or effectiveness of the BEIPC and has not done so in this report.

be used to support the full range of activities that may be desirable to establish healthy communities and ecosystems, and there is no guarantee of long-term funding that is necessary for projects that will take as long to implement and maintain as those proposed in the Coeur d'Alene River basin.¹⁴ Current rules cannot resolve the competing incentives resulting from the distinction between payment of construction costs and O&M costs under fund-financed cleanups. Finally, the liability problems that may be interfering with the adoption of some potentially effective approaches to cleanup remain a problem.

CONCLUSIONS AND RECOMMENDATIONS

Given these problems, the committee believes that an effective program for mining megasites should emphasize long-term management of sites, recognizing that the remediation process inevitably will take decades to complete. The objectives of the program would be to protect human health and the environment, using a combination of institutional controls, active remediation, and habitat restoration. The desirable characteristics of such a program would include the following:

- A stable management structure, which includes federal, state, and local representation
- State and local involvement in defining remediation/restoration goals, considering present and future desired land use
- The ability to address socioeconomic as well as health and environmental aspects of remediation, including the need for economic assistance for low-income communities and provision of health support services for communities living with human health risks
- Long-term commitment to funding, from a mix of state, federal, and private sources

The recommendations below are intended to address problems the committee has observed in the process currently used to remediate large, geographically complex mining sites under Superfund. Most of these rec-

¹⁴This limitation results more from the federal budget process than from any restrictions in the Superfund program. Under the federal budget process, an agency cannot obligate any funds that have not been appropriated. The agency conceivably could work within this restriction by obligating all the funds needed for future work out of current appropriations. However, such an approach is not feasible for two reasons. One is that, given the uncertainty inherent in such a complex site as Coeur d'Alene, there is no way to accurately predict how much money will be required in the future. A second is that any such obligation, even if there were sufficient funds currently available to fulfill it, would divert funds from other sites and substantially disrupt their cleanup.

ommendations can be accomplished within the existing Superfund framework, and some reflect actions that EPA has already undertaken in the Coeur d'Alene River basin. Some recommendations may not be possible under the current Superfund framework. However, even these problems may be addressed in part by Superfund, particularly if there are private sources of funding available. The committee recommends the following:

1. From the beginning, design the data collection, evaluation, and decision-making process so that it is focused on establishing a durable process for long-term management of mining megasites, rather than selecting "final" remedies that cannot truly be final. Because of the long-term commitment required, active involvement by the affected states and local communities is essential. Long-term management requires long-term management structures.

2. Focus on the basic purposes of CERCLA, protecting human health and the environment, and be ready to waive specific ARAR requirements if an effective monitoring program demonstrates that it is not necessary to achieve these numeric standards to achieve these basic purposes. In taking this approach, it is important that the agency specifically define what will be necessary to achieve these goals and what monitoring information will be needed in order to determine when they have been achieved. The goals of protecting human health and protecting the environment are open to multiple interpretations. Experience both within the Coeur d'Alene River basin and with other large sites such as the DOE weapons complex shows that protecting human health can involve a combination of cleanup and institutional controls, depending on the long-term land use projected for a site. The best approach to protecting the environment is to define biological performance goals that are also a function of future land use, and a remedy or suite of remedies should be designed to meet those performance goals.

3. Where it is unlikely that final remedies can be identified and implemented, establish a rigorous adaptive-management process as discussed in Chapter 8, with well-defined performance milestones, monitoring strategies, and evaluation criteria and focus the data collection and analysis activities on supporting this process. An adaptive approach to remediation should be applied consistently. The adaptive approach recognizes that the information needed to design a remedy that will meet all performance goals may not be available when remediation begins. The adaptive-management approach involves establishing goals and developing a monitoring program that measures progress toward the goals and provides data needed to adjust the remedy to meet the goals. This approach also emphasizes continuous real-time evaluation of remediation success and replacement of ineffective or inefficient approaches by more cost-effective approaches. Use of an independent technical advisor panel (see below) to provide oversight could

substantially improve the results obtained from the adaptive management approach.

4. Establish an independent external multidisciplinary scientific review panel to evaluate and advise the agency on critical needs for characterization and remediation decisions at mining megasites as a quality control mechanism. Although establishing an expert review panel may appear to add to the bureaucratic process, at particularly complex sites it may well speed up the cleanup, help avoid unnecessary costs and costly mistakes, as well as provide an acceptable mechanism for resolving technical disagreements. EPA does not have sufficient technical resources to devote to a particular site to conduct the types of technical reviews that are necessary.

5. Broaden the goals of the cleanup to include economic assistance to impacted communities as well as provision of comprehensive medical support services which acknowledge that the effects of toxic waste sites have broad impacts on health. Services would include increased medical support to prevent, diagnose, and counsel community members on the increased risk of cancer, learning/behavioral disabilities, hypertension, pulmonary/cardiovascular disease, and psychiatric illness associated with exposure to environmental toxic waste. Restoration of habitat for ecologic resources should also be provided to the extent required to meet biological performance goals. If these activities cannot be financed under Superfund, explore the possibility of obtaining the necessary support from other federal, state, and nongovernmental entities. If there are viable PRPs associated with the site, the funds they contribute could be allocated to these types of activities.

6. Encourage alternative and innovative technologies including responsible re-mining to clean up at least some of the contamination. If this appears to be a viable option but liability concerns interfere with its implementation, consider offering indemnification to participants, agreeing that any liability will be limited to problems resulting from the remediation activity.¹⁵ It would also be very helpful for EPA to maintain a publicly available source of information on examples of mine-site remediation alternatives that have both succeeded and failed along with general information on their costs and examples of their implementation.

7. Look for opportunities to provide long-term support for implementing and maintaining the cleanup activities and stewardship of the land. Possible sources of such support might include trust funds established from special appropriations by Congress or made available by public and private organizations interested in the site.

¹⁵Such relief obviously should not be afforded to any responsible party at the site that has not entered into a binding settlement agreement with EPA regarding their cleanup liability.

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